PERFORMANCES DIFFERENCE ON CLIMATE BETWEEN AR4 AND AR5

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Intergovernmental Panel on Climate Change (IPCC) merevisi kesan gas rumah kaca (GHG) ke dalam sistem iklim dan mengeluarkan Laporan Penilaian Kelima (AR5) pada tahun 2014. Dengan AR5, perubahan iklim telah diklasifikasikan berdasarkan tahap radiasi memaksa dikenali sebagai Laluan Konsentrasi Perwakilan (RCP2.6, RCP4.5, dan RCP8.5). Versi ini sedikit berbeza dengan versi AR4 yang berdasarkan kumpulan GHG yang dikenali sebagai A1, B1, A2, dan B2. Pengubahsuaian dalam penilaian perubahan iklim akan menjejaskan ketepatan unjuran iklim dalam jangka panjang. Oleh itu, matlamat utama kajian ini adalah untuk menentukan kesan dalam penilaian perubahan iklim antara Laporan Penilaian Keempat (AR4) dengan AR5. Kajian itu difokuskan pada Malaysia Timur termasuk Kelantan dan Terengganu. Dalam kajian ini, Model Downscaling Statistik (SDSM) digunakan sebagai model iklim statistik untuk menilai perbezaan persembahan iklim. Sementara itu, model peredaran umum (GCM) yang disediakan oleh Pemodelan dan Analisis Iklim (CanESM2) digunakan untuk penjanaan iklim jangka panjang. Merujuk kepada hasil, ramalan p-u, r500, dan r850 adalah pembolehubah yang paling mempengaruhi dalam membentuk suhu tempatan dan hujan di kawasan. Ketepatan penjanaan iklim dikawal oleh% MAE yang lebih rendah dengan Korelasi tinggi (R) dalam keputusan yang dikalibrasi dan disahkan. Simulasi suhu berjaya menghasilkan 0.6%% MAE dengan R hampir 1.0. Sementara itu hujan di Terengganu dan Kelantan dihasilkan kurang daripada 14%% MAE dengan 0.99 R. Berdasarkan perbandingan prestasi antara GCM dan data sejarah, RCP4.5 (AR5) dan SRES A2 (AR4) telah dipilih sebagai tahap pemantauan radiasi terbaik di wakil Kelantan untuk AR yang berlainan. Sementara itu untuk Terengganu, RCP2.6 (AR5) dan SRES B2 (AR4) telah dipilih kerana prestasi% MAE yang paling kecil. Keputusan iklim yang diunjurkan dijangka mempunyai kenaikan minimum pada maksimum (0.79%), purata (0.43%) dan suhu min (0.2%). Curah hujan setempat memperlihatkan peningkatan pola dengan (9.37%) di Stesen Gunong Barat Bachok, (5.04%) untuk Stesen Rumah Pam Salor Pengkalan Kubor, (9.11%) untuk Stesen Sg. Simpang Ampat di Kelantan. Bagi Terengganu, pola menunjukkan kenaikan (4.43%) untuk Station Sek Men. Bukit Sawa, (5.25%) untuk Stesen Rumah Pam Pulau Musang, dan (42.07%) untuk Stesen Kg Peringat.

ABSTRACT

The Intergovernmental Panel on Climate Change (IPCC) revised the impact of greenhouse gases (GHGs) into the climate system and came out with the Fifth Assessment Report (AR5) in year 2014. By AR5, the climate changes impact were classified based on the level of radiation forcing known as Representative Concentration Pathways (RCP2.6, RCP4.5, and RCP8.5). This version was slightly difference with the AR4 version which based on the GHGs groups known as A1, B1, A2, and B2. The modification in the climate changes assessment will affecting the accuracy of the climate projection in the long term. Therefore, the main aim of this study was to determine the impact in the climate change assessment between Fourth Assessment Report (AR4) with AR5. The study was focused on Eastern Malaysia including Kelantan and Terengganu. In this study, the Statistical Downscaling Model (SDSM) was used as a statistical climate model to assess the differences of the climate performances. Meanwhile, the general circulation model (GCM) provided by Climate Modelling and Analysis (CanESM2) was used for the long-term climate generation. Referring to the results, the predictor of p-u, r500, and r850 are the most influence variables in forming the local temperature and rainfall at the regions. The accuracy of the climate generation was controlled by the lower %MAE with high Correlation (R) in the calibrated and validated results. The temperature simulation was successfully to produce 0.6% of %MAE with R close to 1.0. Meanwhile the rainfall at Terengganu and Kelantan were produced less than 14% of %MAE with 0.99 of R. Based on the comparison performances between GCMs and historical data, the RCP4.5 (AR5) and SRES A2 (AR4) have been selected as the best radiation forcing level at Kelantan representative for different ARs. Meanwhile for Terengganu, the RCP2.6 (AR5) and SRES B2 (AR4) have been selected due to least %MAE performances. The projected climate results were expected to have minimum increment in the max (0.79%), mean (0.43%) and min (0.2%) temperature. The local rainfall shows increasing pattern with (9.37%) in Station Gunong Barat Bachok, (5.04%) for Station Rumah Pam Salor Pengkalan Kubor, (9.11%) for Station Sg. Simpang Ampat in Kelantan. For Terengganu, the pattern shows an increment of (4.43%) for Station Sek Men. Bukit Sawa, (5.25%) for Station Rumah Pam Pulau Musang, and (42.07%) for Station Kg Peringat.

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LIST OF SYMBOLS

%	Percentage
R	Correlation value

LIST OF ABBREVIATIONS

CIMP5	Coupled Intercomparison Model ver. 5
AR5	Fifth Assessment Report
AR4	Fourth Assessment Report
SRES	Special Report on Emission Scenarios
HadCM3	Hadley Center Coupled Model
RCP	Representative Concentration Pathways
CanESM2	Canadian Center for Climate Modelling Analysis

CHAPTER 1

INTRODUCTION

1.1 Introduction

Climate is the weather conditions of an area in general or for over a long period. Climate can be asses by long term study of the weather of a certain place. The climate can be assessed by a myriad of parameters including temperature, humidity, atmospheric pressure, wind and also precipitation. These parameters can lead us in deciding what the climate of the certain area is and in turn, from climate it was possible to gain the climate trend in which can be assess the changes of the climate towards the future. Climate trend depends on these parameters that can chance involuntary or voluntarily that depends on human actions. These trends can affect a certain area in many ways, such as the increase in temperature can lead to continued warming and many more. To assess these models, it was difficult as it requires to have a proper knowledge on how the cycle works and how are mankind going to interpret the data from General Circulation Model (GCM).

Climate is commonly defined as the weather over a long period. The standard averaging period was 30 years. The period can be lengthened or shorten the period depending on the purpose of the study. It also includes statistics, other than daily averages, such as the magnitudes of day-to-day or year to year variations. In climate, there stands a term called climate normal. These terms were actually a reference point for the climatologists to identify what went astray from the normal climate. A climate that follows the pattern of recent and past climates was a normal climate. In the span of 30 years used as the period of the study, if there are any unnatural occurrences of weather extremes such as heat waves, or heavy precipitation, it can be recorded into the journal for reference about the climate trend, and where the climate trend was heading.

Climate projection is another branch in climate change. Climate projection much more focuses on projections of the climate towards the future. Climate projections are mainly based on the current climate and the climate trend that was ongoing. Climate projection can be also defined as the stimulated response of the climate system to the scenario of future emission or concentration of greenhouse gases and aerosols, that are generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission, the concentration and the radiative forcing scenario used, which was based on assumptions concerning future socioeconomic and technological developments that may or may not be realized. Climate projection has been widely used since the early twentieth century where it is viable to predict the climate change by having calculated the emissions of gases in the atmosphere. Projection can also be determined by the increment of temperature of the atmosphere, whilst neglecting to project climate for the future, it can lead to several problems including decreased productivity in agricultural lands, submerging of suburban areas due to floods or heavy precipitation.

The scientific community has reached a 97% consensus that climate change is influenced by humans yet many people still doubt that this was true (Thompson, 2017).The problems that are in climate can be catastrophic if left unattended. The major climate problems are that there is no correct way of measuring projection in terms of climate. The climate itself presents a question to researchers. The climate itself was handled by the IPCC or the Intergovernmental Panel on Climate Change which was responsible for the climate projection in which the researchers, working for the IPCC assess the climate trend and calculate the climatic change to obtain the projected climate in the future.

The problem arises when there are inconsistencies in certain climatic trends in which can contribute to projection problems. Not forgetting, global climate problems also pave the way to the obstacle in generating climate projections. Such problems, including unnatural climate trends, caused by the presence of GHG in the stratosphere have curbed researchers advances in climate prediction. With the implementation of the Assessment Reports, specifically the Fourth Assessment Report, a system, namely SRES or the Special Reports on Emission Concentration was used to assess the climatic changes and

the climatic problems thus being able to project the climate of the world. The system, is a cry away from perfectness, as the system overestimates the variables that are the guidelines to climate projection. With the implementation of the Fifth Assessment Report, a new system was constructed and it supersedes the SRES. The system, namely RCP focuses on the endpoints and up until now it has been accepted as a sound system by the IPCC. The time to time revision of the climate assessment is necessary due to several issues such as the policy-relevant calculation and overestimate responses of the GHG emissions forcing, reducing regional biases in temperature simulation, the correlation between observed and modelled mean precipitation, uncertainties of cloud processes (Tukimat *et. al.,* 2014).

1.2 Problem Statement

To the International Panel on Climate Change (IPCC) has assessed the amounts of greenhouse gases GHG in various areas of the world. And from these greenhouse gases, the researchers adopted four pathways that are the most prevalent in the stratosphere in today's community. There was a clear view on the increase of the Representative Concentration Pathways (RCPs) throughout the years. The four pathways that have been selected are used for climate modelling and research, which all of them describe different climate projection, all of these pathways consider the amount of GHGs that are emitted in the years to come. The four RCPs, namely RCP2.6, RCP4.5, RCP6 and RCP8.5 are labelled according to possible range of radiative forcing values in the year 2100 in relative to pre-industrial values.

Also assessed by the council of IPCC, the Fourth Assessment Report uses a system that is different from the system that was used in AR5. with the usage of SRES in AR4, the are quite many scenarios that can be obtained through these scenarios. SRES scenarios are emission scenarios developed by (Nakicenovic and Swart, 2000) and used, among others, as a basis for some of the climate projections used in the Fourth Assessment Report. This assessment system was obsolete and was superseded by the Fifth Assessment Report's system which uses the RCP or the Representative Concentration Pathways system. Still, both systems measure and record the increase of the values of GHG and the increase of other features and indicators that are used in measuring the effect of the GHG .

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